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Garima Tak
Department of Entomology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Pradyumn Singh
Scientist, Department of Entomology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Akshat Joshi
Department of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Heenashree Mansion
Ph.D. Research Scholar, Department of Entomology, Agriculture University, Jodhpur, Rajasthan, India

Lokesh Malav
Department of Horticulture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Corresponding Author:
Garima Tak
Department of Entomology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Studies on the distribution against apical twig gall maker (*Betousa stylophora* Swinhoe) on Aonla (*Phyllanthus emblica*) in Gwalior region (M.P.)

Garima Tak, Pradyumn Singh, Akshat Joshi, Heenashree Mansion and Lokesh Malav

Abstract
A survey was carried out at different locations in Gwalior at fortnightly intervals during the year 2021-2022 to investigate the distributional patterns, population dynamics and infestation of apical twig gall maker on aonla. During the distribution studies the infestation level of population dynamics of gall pest was recorded from November 2021 to April 2022. Significant variations in the population dynamics and infestation level were recorded. In the findings, it was revealed that the infestation level ranged from 8.33% to 48.61% among different locations. The population dynamics studies in the present findings revealed that the population count ranged from 0.43 to 10.71 galls/plant. The maximum infestation was noted in Tavopan (48.61%) region which was significantly higher than the other locations while the minimum infestation was found to be in the Krishi Colony (8.33%) location which was significantly lowest among all the locations. The highest gall population was found to be in the Tapovan location (10.71 galls/plant) which was significantly higher than all the other locations i.e. Government nursery (7.99 galls/plant), Jamuna bagh (4.53 galls/plant), Kedarpur-1 (7.07 galls/plant), Kedarpur-2 (5.79 galls/plant), K.V.K (8.40 galls/plant) and Krishi Colony (0.43 galls/plant) which recorded the lowest population significantly.

Keywords: Apical twig gall maker, aonla, distribution, branch infestation, Indian gooseberry

Introduction
Phyllanthus emblica, also known as Indian gooseberry or aonla, is a deciduous tree of the family Phyllanthaceae. The tree is small to medium in size, reaching about 1-8 m in height. It possesses a high productivity unit area and is of a good deal of interest among research scientists. Aonla fruit is one of the richest sources of ascorbic acid, Vitamin "C" (500-700 mg per 100 g pulp) and antioxidants. Incorporating the superfruit in your diet may improve your overall health. The bitter taste may derive from the high density of ellagitannins.

Aonla has recorded various diseases like fruit rot, wilt, rust, sooty mould and anthracnose. A variety of insect pests are recorded in Aonla. The major pests are *Betousa stylophora* Swinhoe, *Gracillaria acidula* (Meyrick), *Selepa celtis* Moore and *Indarbela tetraonis* Moore belonging to the order Lepidoptera, *Cerciaphis emblica*, *Nipaecoccus vastator* (Maskell) and *Oxyrhachis tarandus* Fabricius of Homoptera, *Myllocerus discolor* Boheman of Coleoptera and termite, *Odontotermes* spp. of Isoptera. Among the natural enemies, two species of coccinellid beetles *viz*., *Cheilomenes* (*Menochilus*) *sexmaculata* Fabr. and *Coccinella septempunctata* Linn. Four species of spiders (*Neoscona* sp., *Peucetia* sp., *Argiope* sp. and *Oxyopes* sp.) are generally found on the aonla crop.

Infestation of major pests like apical twig gall maker is a major problem in aonla cultivation in many parts of the country. Eggs are laid on the leaves of aonla by the moth in the month of June. During the infestation of a major pest twig gall maker, terminals swell, which increases in size with the passage of time. Fresh galls are seen in July-August and a peak of infestation can be seen in the month of October-November [Chandha (2001), Meshram *et al.* (2003), Singh and Mishra (2007), Bharpoda *et al.* (2009), Kulkarni *et al.* (2014), Singh and Kaur (2015), Haldhar (2019)] [2, 6, 7, 1, 5, 8, 4].

In Madhya Pradesh, the area under aonla cultivation has increased over the years owing to its high productivity. As cultivation is increasing, the farmers in the M.P. region are facing problems with insect pests in the berry crop. Keeping all the points in mind, the present research work was carried out at different locations in Gwalior to find out the distribution of apical twig gall maker on aonla in Gwalior region.

Materials and Methods

The study on the seasonal incidence was conducted in the aonla orchard of K.V.K, Gwalior during 2021-2022. Gwalior is situated in the north-west part of Madhya Pradesh. The climatic conditions of Gwalior are subtropical and semi-arid. The temperature rises up to 48° C in the summer and falls down to 1° C in the winter, with the occasional occurrence of frost. The average annual rainfall is 750 mm, which is received between June to September.

For studying the distribution of twig gall maker infestation in Gwalior region, seven aonla orchards at various different locations were surveyed at fortnightly intervals and the observations were recorded on the incidence of twig gall maker. Randomly three plants were selected per orchard. On each plant, three branches were selected randomly. Twig gall maker population was counted. Each location was treated as a treatment. The data recorded was analyzed by randomized block design.

The details of the experiment are as follows

Design: Randomized Block Design (RBD)
Treatments (Locations): 07
Replications: 03

Results and Discussions

The farmers get a variable quantity of production of aonla crop among different locations of Gwalior. This might be due to the different infestation level of the major pest of aonla crop. The infestation levels of population dynamics of gall pest was recorded from November 2021 to April 2022. In the present findings, it was revealed that the infestation level ranged from 8.33% to 48.61% among different locations. The population dynamics studies in the present findings revealed that the population count ranged from 0.43 to 10.71 galls/plant. The maximum infestation was noted in Tavopan region was significantly higher than the other locations while the significantly minimum infestation was found to be in Krishi Colony location.

According to the present findings all the observations showed a significant difference among all the 12 observations. The population of gall was found to be significantly different in all the locations during the course of study. According to the pooled analysis all the locations showed significantly different populations of galls on aonla. The highest gall population was found to be in Tapovan location (10.71 galls/plant) which was significantly higher than all the other locations i.e. Government nursery (7.99 galls/plant), Jamuna bagh (4.53 galls/plant), Kedarpur-1 (7.07 galls/plant), Kedarpur-2 (5.79 galls/plant), K.V.K (8.40 galls/plant) and Krishi Colony (0.43 galls/plant) which recorded the significantly lowest population.

According to the present experimental results the infestation level was found to be significantly different in all the 12 observations which were taken at different fortnights between November 2021 to April 2022. All the 12 observations showed significantly different infestation level among different locations fortnightly. The highest percent infestation was found to be in Tapovan location (48.61%) which was significantly higher than the rest of the locations i.e. K.V.K (36.66%), Jamuna bagh (31.94%), Kedarpur-1 (33.89%), Kedarpur-2 (33.36%), Government nursery (36.94%) and Krishi Colony (8.33%) which recorded the lowest significant infestation among all the locations. On the basis of pooled analysis, all the locations showed significantly different infestation levels of gall.

In accordance to the earlier studies from literature, there is no such study carried out with the distribution pattern of gall among different locations among Gwalior region except Dhanoliya (2017) [3] who carried out the distribution studies on the *Betousa stylophora* among different localities of Gwalior. The occurrence of *Betousa stylophora* on aonla in different locations of Gwalior indicates the urgent need to take control measures against the pest to help the farmers get a better yield of aonla crop.

Table 1: Distribution of gall population in different locations of Gwalior during 2021-2022.

Locations	Mean gall population/20cm/3 branches/plant in different fortnights (Variety NA-7)												Mean
	Nov		Dec		Jan		Feb		Mar		April		
	I	II	I	II	I	II	I	II	I	II	I	II	
Govn nursery	5.11 (2.36)	5.43 (2.42)	6.44 (2.63)	7.11 (2.76)	7.44 (2.82)	8.00 (2.92)	8.33 (2.97)	8.66 (3.03)	9.00 (3.08)	9.33 (3.14)	10.00 (3.24)	11.00 (3.39)	7.99 (2.90)
Jamuna Bagh	5.55 (2.46)	5.00 (2.34)	4.11 (2.14)	4.00 (2.11)	5.00 (2.34)	5.55 (2.43)	2.22 (1.65)	2.55 (1.75)	6.66 (2.67)	7.33 (2.79)	3.00 (1.86)	3.33 (1.95)	4.53 (2.21)
Krishi colony	0.33 (0.91)	0.33 (0.91)	0.33 (0.91)	0.33 (0.91)	0.44 (0.97)	0.44 (0.97)	0.55 (1.02)	0.55 (1.02)	0.33 (0.91)	0.33 (0.91)	0.44 (0.97)	0.77 (1.13)	0.43 (0.96)
Kedarpur 1	3.33 (1.96)	4.33 (2.20)	5.00 (2.35)	6.00 (2.55)	6.44 (2.63)	7.00 (2.74)	7.22 (2.78)	8.00 (2.92)	8.22 (2.95)	9.00 (3.08)	9.66 (3.19)	10.66 (3.34)	7.07 (2.72)
Kedarpur 2	2.00 (1.58)	2.22 (1.63)	3.00 (1.87)	3.22 (1.93)	4.00 (2.12)	4.77 (2.30)	6.33 (2.55)	7.00 (2.74)	8.00 (2.92)	7.33 (2.80)	10.00 (3.24)	11.66 (3.49)	5.79 (2.43)
KVK	6.43 (2.63)	7.86 (2.89)	7.40 (2.81)	8.33 (2.97)	8.00 (2.91)	8.20 (2.95)	8.73 (3.03)	8.76 (3.04)	8.33 (2.96)	9.11 (3.10)	7.44 (2.80)	12.22 (3.56)	8.40 (2.97)
Tapovan	10.11 (3.26)	9.33 (3.13)	11.11 (3.41)	6.66 (2.68)	7.66 (2.86)	12.55 (3.61)	11.10 (3.41)	10.44 (3.31)	11.55 (3.47)	12.44 (3.60)	10.00 (3.32)	14.99 (3.94)	10.71 (3.33)
S.Em(±)	0.08	0.12	0.08	0.05	0.07	0.12	0.06	0.07	0.09	0.07	0.11	0.07	0.02
CD (5%)	0.24	0.38	0.24	0.17	0.23	0.36	0.18	0.20	0.29	0.21	0.33	0.22	0.06

Figures in the parenthesis are square root transformed values

Table 2: Percent branch infestation on aonla in different locations of Gwalior during 2021-2022.

Locations	Percent branch infestation (Variety NA-7)												
	Nov		Dec		Jan		Feb		Mar		April		
	I	II	I	II	I	II	I	II	I	II	I	II	
KVK	30.00 (33.21)	33.33 (35.22)	23.33 (28.78)	30.00 (31.00)	30.00 (33.21)	36.66 (37.22)	30.00 (33.21)	43.33 (41.15)	60.00 (50.77)	23.33 (28.78)	53.33 (46.92)	46.00 (43.08)	36.66 (36.88)
Tapovan	30.00 (33.21)	20.00 (26.57)	40.00 (39.23)	43.33 (41.15)	53.33 (46.92)	46.66 (43.08)	56.66 (48.85)	56.66 (48.85)	60.00 (50.77)	43.33 (41.15)	63.33 (52.78)	70.00 (56.79)	48.61 (44.11)
Krishi colony	3.33 (6.14)	3.33 (6.14)	6.66 (12.29)	6.66 (12.29)	6.66 (12.29)	6.66 (12.29)	10.00 (18.43)	10.00 (18.43)	10.00 (18.43)	13.33 (21.14)	13.33 (21.14)	10.00 (18.43)	8.33 (14.79)
Jamuna bagh	20.00 (26.57)	10.00 (18.43)	30.00 (33.21)	30.00 (33.21)	30.00 (41.15)	36.66 (37.22)	20.00 (26.57)	30.00 (33.21)	40.00 (39.23)	40.00 (39.23)	50.00 (45.00)	46.66 (43.08)	31.94 (34.68)
Kedarpur 1	30.00 (33.21)	20.00 (26.57)	30.00 (33.21)	20.00 (26.57)	23.33 (28.78)	23.33 (28.78)	43.33 (41.15)	30.00 (33.21)	53.33 (46.92)	43.33 (41.15)	30.00 (33.21)	60.00 (50.77)	33.89 (35.29)
Kedarpur 2	17.00 (23.86)	30.00 (33.21)	23.33 (28.78)	23.33 (28.78)	26.66 (31.00)	26.66 (31.00)	43.33 (41.15)	43.33 (41.15)	43.33 (41.15)	33.33 (35.22)	40.00 (39.23)	50.00 (45.00)	33.36 (34.96)
Govn nursery	30.00 (33.21)	30.00 (33.21)	23.33 (28.78)	26.66 (31.00)	30.00 (33.21)	36.66 (37.22)	53.33 (46.92)	53.33 (46.92)	53.33 (46.92)	33.33 (35.22)	33.33 (35.22)	40.00 (39.23)	36.94 (37.26)
S.Em (±)	2.69	2.50	2.91	2.56	2.91	3.24	1.36	1.36	1.26	2.09	1.65	0.94	0.64
C.D. (5%)	8.29	7.71	8.97	7.90	8.96	9.97	4.19	4.19	3.88	6.44	5.09	2.89	1.79

Figures in the parenthesis are angular transformed values

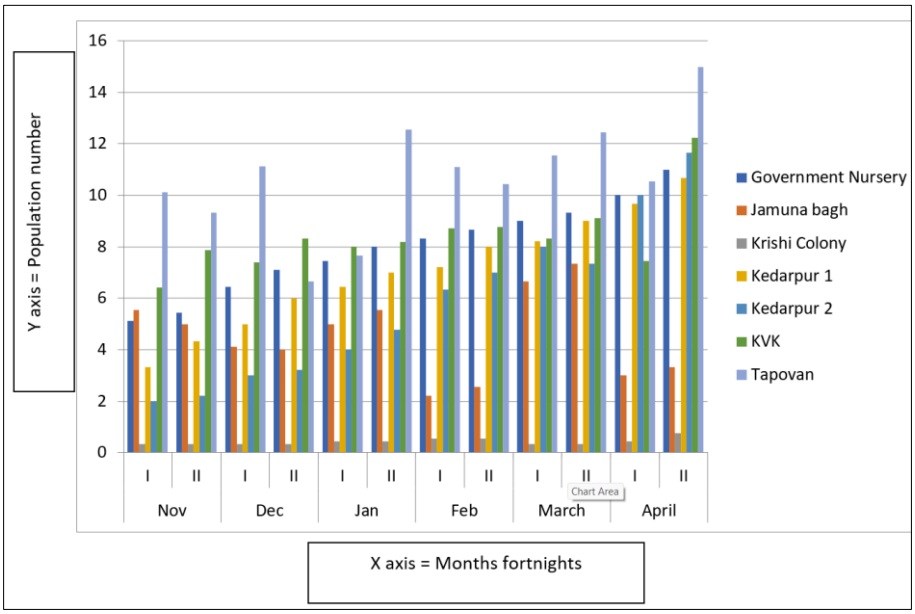

Fig 1: Distribution of gall population at different locations in Gwalior during 2021-2022.

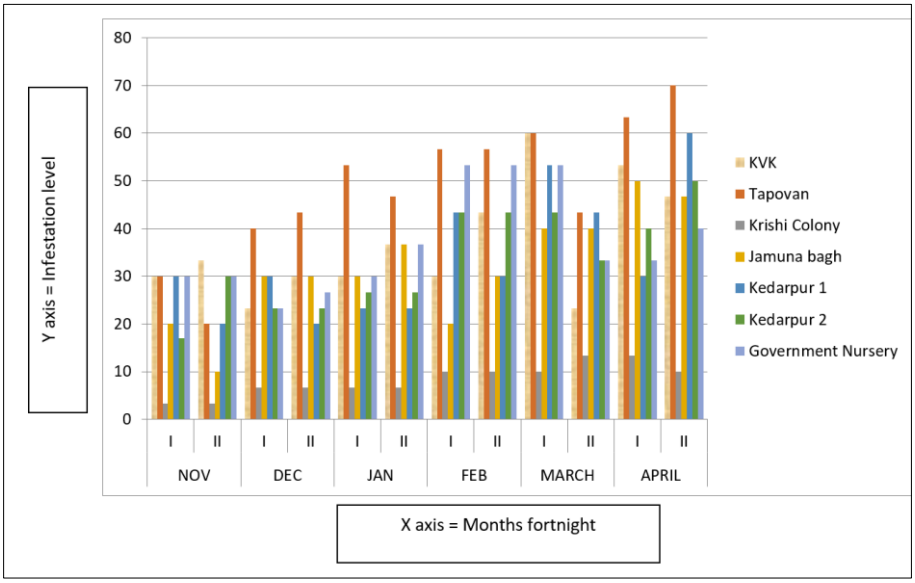

Fig 2: Percent infestation at different locations of Gwalior during 2021-2022.

Conclusion

A significant difference in pest populations and infestation levels was recorded in all localities. Maximum gall activity was found in Tapovana and minimum was found in Krishi Colony.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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